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Claims

1.   A method of error compensation for measurements
taken using a co-ordinate positioning apparatus
5   comprising an articulating probe head having a surface
detecting device, wherein the surface detecting device
is rotated about at least one axis of the articulating
probe head during measurement, the method comprising
the following steps in any suitable order:
10   (a)   determining the stiffness of the whole or
part of the apparatus;
          (b)   determining the load or one or more factors
which relate to the load applied by the articulating
probe head at any particular instant;
15   (c)   determining the measurement error at the
surface sensing device caused by the load, using the
data from steps (a) and (b).

2.   A method according to claim 1 wherein the load
20   comprises a torque.

3.   A method according to any preceding claim wherein
the load comprises a linear force.

25   4.   A method according to any preceding claim wherein
the surface sensing device is a contact probe.

5.   A method according to any of claims 1-3 wherein
the surface sensing device is a non-contact probe.
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6.   A method according to any preceding claim wherein
the stiffness is determined in step (a) by applying a
load to the whole or part of the apparatus and
measuring the deflection.

7.   A method according to any of claims 1-5 wherein the stiffness is determined in step (a) by:

measuring an object of known dimensions whilst
5   measuring the load applied to the whole or part of the apparatus;

wherein the deflection of the whole or part of the apparatus is determined from the difference between the known and measured dimensions of the object; and

10   wherein the stiffness is derived from the load and the deflection.

8.   A method according to claim 7 wherein the known dimensions of the object are determined by measuring it
15   at a slow speed.

9.   A method according to any of claims 1-5 wherein the surface sensing device is a contact probe having a workpiece contacting stylus, and wherein the stiffness
20   is determined in step (a) by:

positioning the contact probe so that the stylus is in contact with the surface of an object of known dimensions;

taking measurement readings of the surface when
25   different probe forces are applied;

wherein the deflection of the whole or part of the apparatus is determined from the difference between the known and measured dimensions; and

wherein the stiffness is derived from the applied
30   force and the deflection.

10.   A method according to any of claims 1-5 wherein the surface sensing device is a contact probe having a workpiece contacting stylus, and wherein the stiffness

is determined in step (a) by:

        positioning the contact probe so that the stylus
is in contact with the surface of an object of known
dimensions;

5   oscillating the probe head as the probe tip
remains in contact with the surface;

        taking measurement reading of the surface when
oscillating at different probe frequencies and hence
accelerations;

10   wherein the deflection of the whole or part of the
apparatus is determined from the difference between the
known and measured dimensions; and

        wherein the stiffness is derived from the
acceleration and deflection.

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11.   A method according to any preceding claim wherein
the one or more factors which relate to the load in
step (b) is determined from system variables of the
apparatus.

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12.   A method according to claim 11 wherein the one or
more factors which relate to the load in step (b) is
determined from the current applied to at least one
motor in the articulating probe head.

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13.   A method according to claim 11 wherein the one or
more factors which relate to the load in step (b) is
determined by double differentiation of the measurement
data from the position measuring device in the

30 articulating probe head.

14.   A method according to any of claims 1-9 wherein
the one or more factors which relate to the load in
step (b) is determined using a torque meter or

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accelerometer.

15.   A method according to any preceding claim, the
method including the step of determining the offset of
5   the measurement path of the surface sensing device from
a datum point, and wherein this offset is used in
calculating the measurement error.

16.   A method according to claim 15, wherein the
10   measurement error determined in step (c) is
substantially proportional to $(L\cos\varphi)\delta\theta$, wherein L is
the distance from a datum point in the articulating
probe head to the measurement path of the surface
sensing device, φ is the angle between the surface
15   sensing device and an axis normal to the axis of a
structure onto which the articulating probe head is
mounted and $\delta\theta$ is the angular deflection of the mount.

17.   A method according to claim 16, wherein the probe
20   is a contact probe and L is the distance between the
tip of the surface sensing device and the centre of
rotation.

18.   Co-ordinate positioning apparatus comprising an
25   articulating probe head having a surface detecting
device, wherein the surface detecting device is
rotatable about at least one axis of the articulating
probe head, the stiffness of the whole or part of the
apparatus being known;
30   the apparatus being provided with means to
determine one or more factors which relate to the load
applied by the articulating probe head at any
particular instant;

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and wherein the co-ordinate positioning apparatus includes a processor adapted to determine the measurement error at the surface sensing device caused by the load, using the known stiffness of the whole or

5   part of the apparatus and the determined one or more factors relating to the load.